

Diet of Willow Grouse *Lagopus lagopus* chicks on a coastal Island

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On a coastal island in northern Norway insects dominated the food of chicks of Willow Grouse *Lagopus lagopus* in the first week of life. Most important families were Diptera and Leptoptera. Reproductive parts accounted for a larger part of the plant material. Differences in the chicks' diet in different areas may partly be ascribed to differing relative availability of important species.

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INTRODUCTION

Insects predominate in the diet of chicks of Willow Grouse *Lagopus lagopus* (L.) in the first days of life, while older chicks feed mainly on plants (Lid & Meidell 1933). Also small chicks of Rock Ptarmigan *Lagopus mutus* eat insects often (Weeden 1969, Gardarsson & Moss 1970). But Red Grouse *L. lagopus scoticus* chicks can survive well on a diet with 5% insects (Savory 1977).

The occurrence of insects in crops of small *Lagopus* spp. chicks varies with the geographical area (e.g. Granström 1980). Spidsø (1980) has also shown a large annual variation in the composition of the insect diet of Willow Grouse chicks on Tranøy island in northern Norway in 1974–1975.

This paper presents data on the crop contents of grouse chicks from Tranøy, collected in the period 1961–1970. The Tranøy material with Spidsø's (1979, 1980) data from 1974–1975 included is compared with data from mountain areas in southern Norway given by Meidell & Lid (1933) and Christiansen & Krafft (1953) and recalculated here by me. The nutritional quality of the chicks' food is also discussed.

STUDY AREA

Tranøy ($69^{\circ}09'N - 17^{\circ}25'E$) is a coastal island, 127 hectares in area, located in Troms county between the large island of Senja and the mainland. The vegetation is patchy, comprising forest (44%), heaths (25%), cultivated land (12.5%) bogs and fens (8%) and shore communities (3.5%) (Myrberget 1975a).

Myrberget & Erikstad (1976) list 235 higher plants from the area. The dominant tree is *Betula pubescens*, usually less than 5 metres high (Myrberget 1975a). *Empetrum hermaphroditum* dominates the ground vegetation, covering 23% of the area. Other common ground species are *Cornus suecica* (8% area), *Calluna vulgaris* (4%), *Vaccinium myrtillus* (4%), *V. vitis-idaea* (4%), *V. uliginosum* (2%) and *Andromeda polifolia* (1%). Various species of mosses (Bryales) are included in all vegetation types (18% cover), while *Carex* spp. (3%) are most common on bogs and fens. Cultivated land excluded, 15% of the island is covered by a mixture of other herbs and grass.

MATERIAL AND METHODS

A total of 66 chicks up to the age of 35 days were killed by accident in the course of other field studies of the grouse. Yearly number of chicks varied from 3 to 11. They were collected at all hours of the day, but most of them in the afternoon and evening, that is to say, during the chicks' most important feeding period (Krafft 1954, Savory 1977).

A few chicks could be aged correctly, as their claws had previously been cut according to a code while in the nest. For the years 1964–1969, the approximate age was found using the growth curve for the area in each individual year (Myrberget et al. 1977), while in other years the «average» growth curve for Tranøy was used (Myrberget 1975b). The age distribution of the chicks is given in Tab. 1.

Table 1. Food characteristics of different age groups (days) of chicks 1961–1970. Dry weights in mg.
No = number.

Age in days	0–6	7–13	14–20	21–35
No. of chicks	13	11	21	21
No. of empty crops	2	1	3	2
Mean crop weight ¹⁾	12	66	50	237
Max. crop weight	48	225	189	2068
% of weight animalic	64	12	9	3
% of crops with animals ²⁾	82	90	67	58
Mean no. of animals ¹⁾	11	26	5	9
Max. no. of animals	56	85	47	76
Mean ind. animal weight	0.7	0.3	1.4	0.7

1) Empty crops included

2) Empty crops excluded

The chicks were kept in formalin, and only crop contents were examined. The different food items were oven dried for 1–2 days at 100°C, and then weighed to the nearest 0.1 mg. A count was made of the different numbers of animals. For plants, only dry weights were recorded.

The total dry plant material weighed 6486.4 mg, of which 46.4 mg was indeterminable. The animals weighed 463.2 mg and comprised 775 individuals, of which three could not be identified. Insects were determined to family, other animals to the order only.

RESULTS

Composition of the diet

Eight (12%) of the 66 crops were empty (Tab. 1). Five crops contained only animals, 17 only plants and 36 a mixture of both.

On average, each crop contained 12 animals with a mean individual dry weight of 0.6 mg. Mean plant weight per crop was 98 mg, mean animal weight 7 mg. Animals thus comprised 6.7% of the total material.

With increasing age of the chicks, the average dry weight of the crop contents increased and the percentage weight of animals in the diet decreased (Tab. 1). The average number of animals per crop reached a peak of 26 individuals in the second week of life. 80–90% of chicks up to age two weeks had eaten animals, while approximately 60% of the filled crops of older chicks included animals (Tab. 1).

Plant food

Andromeda polifolia was the most important food plant in the first two weeks of life (Tab. 2). Other plants often eaten in the early days were

various mosses, *Polygonum viviparum*, *Vicia cracca*, *Vaccinium myrtillus* and *V. uliginosum*. The mosses comprised 58% *Polytrichum*, 39% *Polia* and 3% *Hypnum* spp.

Older chicks had eaten mainly *Vaccinium uliginosum*, *Vicia cracca* and *Empetrum hermaphroditum*. *Gymnocarpium dryopteris*, *Polygonum viviparum*, *Ranunculus acris*, *Vaccinium myrtillus* and *Galium boreale* were also important (Tab. 2).

Reproductive parts accounted for 64% of the total plant material. The dominance of reproductive parts was especially significant in chicks of age less than two weeks, when 83% of the plant food consisted of parts such as moss capsules, *Polygonum* spikes and bulbils, *Andromeda* flowers, as well as some flowers and berries of *Vaccinium* and *Empetrum*.

In older chicks, 50% of the plant material comprised reproductive parts, the most important being *Empetrum* berries (95% of the *Empetrum* material). The *Vaccinium* material included 2.5% flowers and berries. The chicks had eaten seeds of *Luzula*, *Juncus* and *Carex* spp., and of different herbs, e.g. *Ranunculus*.

Animal food

Insects comprised the main part (96%) of the animal food (Tab. 3). Two crops also contained small gastropods (Pulmonata), and a third contained one or more arachnoids (Opiliones, Araneae and Acari).

About half of the insects were Diptera. The most frequent dipter family was Sciaridae, but Tipulidae, Phagionidae and Muscidae were also important because of the high individual weights (Tab. 3).

Table 2. Plant food 1961–1970 distribution in 53 chicks (18 ind. 0–13 days, 35 ind. at least 14 days). F = % of crops. W = Distribution (%) of dry weights. t = traces (less than 0.05%).

	1–13 days		14–35 days		Total
	F	W	F	W	W
Bryales	17	2.5	6	0.7	0.9
<i>Gymnocarpium dryopteris</i>	5	1.0	11	6.4	5.9
<i>Ducus sp.</i>	5	t	6	t	t
<i>Luzula pilosa</i>	0	—	9	0.9	0.8
<i>Carex sp.</i>	0	—	9	0.1	0.1
<i>Betula nana</i>	5	t	0	—	t
<i>Polygonum viviparum</i>	17	8.1	14	9.6	9.5
<i>Stellaria sp.</i>	0	—	3	t	t
<i>Cerastium alpinum</i>	5	0.3	3	t	t
<i>Thalictrum alpinum</i>	5	t	0	—	t
<i>Ranunculus acris</i>	0	—	6	5.1	4.6
<i>Vicia cracca</i>	11	2.2	37	14.4	13.1
<i>Trifolium repens</i>	0	—	3	1.3	1.2
<i>Viola sp.</i>	0	—	3	t	t
<i>Pyrola sp.</i>	0	—	3	t	t
<i>Loiseleuria procumbens</i>	5	0.3	0	—	t
<i>Andromeda polifolia</i>	33	73.0	6	0.3	7.7
<i>Calluna vulgaris</i>	0	—	11	0.7	0.6
<i>Vaccinium uliginosum</i>	22	5.2	40	33.3	30.5
<i>Vaccinium myrtillus</i>	28	6.1	31	5.4	5.5
<i>Empetrum hermaphroditum</i>	11	0.5	40	18.0	16.2
<i>Melampyrum pratense</i>	0	—	6	0.1	0.1
<i>Euphrasia sp.</i>	0	—	3	t	t
<i>Plantago major</i>	0	—	3	t	t
<i>Galium boreale</i>	11	0.8	17	3.4	3.1
<i>Campanula rotundifolia</i>	0	—	3	0.1	0.1
<i>Betonica sp.</i>	0	—	3	t	t

Lepidoptera was the most important insect order after Diptera, and the material comprised mainly Geometridae caterpillars with high individual weights. Among Hemiptera, species of Aphididae and Cicadidae were important as food. The order Hymenoptera was represented in many chick crops by Tenthredinidae larvae, some adult Parasitica and some larger ants (Formicidae). The orders Collembola, Plecoptera, Mallophaga, Thysanoptera, Coleoptera and Trichoptera were present, but in insignificant quantities.

DISCUSSION

Differences between the years

The material from individual years in the period 1961–1970 was too small to evaluate annual differences in diet. Compared with Spidsø's (1979, 1980) data from Tranøy in 1974 and 1975, the 1961–1970 material contained less mosses, *Carex* spp. and *Vaccinium myrtillus*, and more *V. uliginosum*. The most important annual difference in animal food in Spidsø's material concerned Lepidoptera larvae, which in 1974 represented two thirds by weight and in

Table 3. Animal food distribution in 41 chicks from 1961–1970. F = % of crops. N = Distribution (%) of numbers. W = Distribution (%) of dry weights. AV = Average dry weight (mg) of individuals.

	F	N	W	AV
Pulmonata	2	0.1	0.4	1.9
Opiiones	2	0.5	1.9	2.2
Arenaceae	15	1.2	0.7	0.3
Acarai	24	1.3	1.0	0.5
Insecta				
Collembola	5	4.9	1.6	0.2
Plecoptera				
Neurotidae	2	0.1	0.3	1.2
Nemouridae	2	0.1	0.2	1.1
Mallophaga	2	0.1	0.1	0.4
Hemiptera				
Aphididae	22	24.3	6.7	0.2
Cicadidae	24	2.7	2.9	0.7
Psyllidae	5	1.8	0.4	0.1
Tingidae	5	0.3	0.1	0.3
Indet.	2	0.1	0.1	0.5
Thysanoptera	10	0.5	0.3	0.4
Coleoptera				
Staphylinidae	5	0.5	0.1	0.1
Cantharidae	2	0.1	0.1	0.6
Indet. (larvae)	2	0.4	0.1	0.2
Hymenoptera				
Tenthredinidae (larvae)	15	1.9	2.4	0.8
Formicidae	7	0.4	3.1	4.8
Parasitica	24	2.1	1.1	0.3
Lepidoptera				
Microlepidoptera	17	1.7	1.7	0.6
Geometridae (larvae)	17	5.9	28.8	2.9
Indet. (larvae)	7	0.6	1.5	1.4
Trichoptera	2	0.3	1.3	3.0
Diptera				
Tipulidae	24	2.7	4.1	0.9
Culicidae	5	0.4	0.2	0.3
Chironomidae	12	1.2	0.8	0.4
Simuliidae	2	0.1	0.1	0.4
Ceratopogonidae	5	3.5	0.5	0.1
Bibionidae	5	0.4	0.4	0.6
Mycetophilidae	7	0.6	0.5	0.7
Sciariidae	46	22.6	7.1	0.2
Nematocera indet.	15	1.3	1.0	0.4
Rhiniidae	10	1.3	15.2	7.1
Empididae	41	5.8	3.7	0.4
Dolichopodidae	7	0.4	0.8	1.3
Lonchopteridae	5	0.4	0.2	0.3
Pipunculidae	10	0.5	0.3	0.4
Drosophilidae	2	0.1	0.1	0.4
Muscidae	24	4.3	6.4	0.9
Spaeroceridae	2	0.1	0.1	0.2
Chloropidae	7	0.9	0.3	0.2
Heleomyzidae	2	0.1	0.2	0.7
Cyclorrhapha indet.	15	1.0	1.1	0.6

1975 one fifth. In 1961–1970 these larvae comprised one third of the animal food.

In my material insects dominated in the diet in the chicks' first week but already in the second week had dropped to only 12% of the total food by weight. This drop is probably more pronounced than in 1974 and 1975, since Spidsø (1979) stated that for 4–5 day old chicks the insect content of the food was 20% in 1961–1970, against 45% in 1974 and 1975.

Geographical differences

In contrast to the Tranøy material, the insect diet of 4 week old Willow Grouse chicks in southern Norway comprised as much as about a third of the food weight, and there was no drop in the number of animals per crop from the first to the fourth week (Tab. 4). Similarly, in an area in northern Sweden, insects seem to be of great-

Table 4. Main food characteristics for Willow Grouse chicks from southern Norway. Calculations are based on material by Meidell & Lid (1933) and Christiansen & Krafft (1953). Wet weights in mg. No-Number. The size groups of the chicks correspond roughly to the age groups used in Table 1.

Chick size (g)	12–25	25–50	50–100	100–200
No. of chicks	37	30	19	17
No. of empty crops	12	6	1	2
Mean crop weight ¹⁾	74	296	781	755
Max. crop weight	398	2229	2569	4199
% of food animalic				
Numbers	69	42	18	19
Weights	65	50	31	35
% of crops with animals ²⁾	88	83	83	73
Mean number of animals ¹⁾	19	22	23	29
Max. number of animals	215	205	78	354
Mean number of plants ¹⁾	9	31	106	126
Max. number of plants	59	215	515	1251
Mean ind. animal weight	3.1	4.8	5.1	8.9
Mean item plant weight	2.6	5.6	6.0	4.9

1) Empty crops included

2) Empty crops excluded

Table 5. Percentage distribution of plant food species in crops of chicks on Tranøy compared with chicks from mountain areas in southern Norway. For Tranøy dry weight distribution is given, and Spidsø's (1979, 1980) material for 1974–1975 is included. Wet weight distribution for southern Norway is calculated from data on Willow Grouse chicks up to 200 grams given by Meidell & Lid (1933) and Christiansen and Krafft (1953). t = traces.

	Tranøy	S. Norway
Bryales	2.9	19.2
Polypodiaceae	3.8	0.1
Equisetaceae	—	0.4
Juncaceae	1.2	0.1
Gramineae	0.1	—
Carex spp.	4.8	3.3
Salix spp.	—	7.7
Betula spp.	t	1.8
Polygonum viviparum	8.0	13.6
Andromeda polifolia	5.4	1.3
Calluna vulgaris	1.1	t
Vaccinium uliginosum	20.0	19.3
Vaccinium myrtillus	11.5	12.8
Vaccinium vitis-idaea	0.3	4.8
Empetrum spp.	21.2	5.6
Other herbs	19.7*	10.1

*In addition to most species listed for 1961–70 in Table 2, small amounts of *Rumex acetosella*, *Rubus chamaemorus*, *Cornus suecica*, *Trientalis europaea* and *Rhinanthus minor*.

ter importance to older chicks than on Tranøy (Granström 1980).

Tabs. 5 and 6 compare the composition of the chicks' diet on Tranøy (Spidsø's data included) with the diet of chicks in southern Norway. These data are not directly comparable, however, due to differences in the age composition of the chicks from the two areas.

The lower amount of the highly preferred *Polygonum* bulbs in chick crops from Tranøy than in crops from southern Norway (Tab. 4) and from Karlsøy, another coastal island in the county of Troms (Barth 1949) is possibly because *Polygonum* only occurs in small quantities on Tranøy, and mainly close to cultivated meadows and the shore. Similarly, *Salix* spp. were not demonstrated as food on Tranøy, where they occur in small quantities, but were important as food for the chicks in southern Norwegian mountain areas.

Of the heath species, berries of *Empetrum*, the dominant ground species on Tranøy, were common in the diet of larger chicks. Leaves and shoots of *Vaccinium myrtillus* and *V. uliginosum* were eaten frequently both on Tranøy and in southern Norway (Tab. 5). In both areas, the slight occurrence in the food of *Calluna vulgaris* and *Cornus suecica* is probably due to a low preference for these species (Spidsø 1980). Chicks of Red Grouse, on the other hand, eat

mainly *Calluna* (Lance & Mahon 1975, Savory 1980).

Both on Tranøy and in southern Norway, Diptera was an important insect order in the chicks' diet (Tab. 6). That *Lagopus* chicks frequently eat Diptera is also found for Willow Grouse in northern Sweden (Granström 1980), for Rock Ptarmigan in Alaska (Theberge & West 1973), and for Red Grouse in Scotland (Savory 1977).

While lepidoptera was the most important insect food by weight on Tranøy, such larvae were not often eaten by Willow Grouse chicks in southern Norway and northern Sweden (Tab. 6 and Granström 1980). The diet in these areas was dominated by Tenthredinidae (Hymenoptera) larvae. These larvae live on the leaves of *Salix* spp. which are not abundant on Tranøy.

The diet of Willow Grouse chicks (Red Grouse included) thus varies somewhat from area to area. Even if we have no exact information on the potential animal and plant foods in the different study areas, the data suggest that the composition of the chicks' diet is highly influenced by the relative occurrence of potential food species.

Food quality

Little is known about the nutrient requirements of wild Willow Grouse chicks, but both Willow and Red Grouse chicks have been successfully reared in captivity on foods with known chemical composition. The artificial diet used for Willow Grouse chicks at Tromsø, Norway, contains 22% crude protein (Moss & Hanssen 1980). The growth requirement of young poultry is 20–30% protein (Agricultural Research Council 1963). Chicks of Bobwhite Quail *Colinus virginianus*, pheasants *Phasianus* spp., and Red-legged Partridge *Alectoris graeca*, grow fastest with a food protein content of 28% (Andrews et al. 1973, Woodard et al. 1977, 1979).

Leaves of most food plants relevant on Tranøy contain less than 20% crude protein (Spidsø 1980). But since a major part of the vegetable food comprises reproductive parts such as capsules, bulbils, flowers and seeds, the chicks' food is relatively rich in protein and soluble carbohydrates (e.g. Gardarsson & Moss 1970, Spidsø 1980). Berries are poor in protein, however, but have a fairly high sugar content (Pulliainen et al. 1968, Moss & Parkinson 1975). *Vaccinium myrtillus* leaves have a high ascorbic acid content, which growing chicks are unable to produce in sufficient quantities to fulfil their requirements (Hanssen et al. 1979).

The insects in the diet of small Willow Grouse chicks are particularly rich in protein, 40–60% (Gross 1966). Since a high protein content gives rapid growth, a rich abundance of insects may give particularly rapid growth of young chicks. This is supported by the fact that in 1966, 1967 and 1980, years with large numbers of lepidopter caterpillars (*Operophtera* sp.) on Tranøy, the growth rates for the Willow Grouse chicks were especially high (Myrberget et al. 1977, and unpubl. data).

Table 6. Percentage distribution of animal food in crops of chicks on Tranøy compared with chicks from southern Norway. Calculations for Tranøy and for S. Norway are made as in Table 5.

t = traces. N is percentage distribution of numbers, DW of dry weights and WW of wet weights.

	Tranøy N	Tranøy DW	S. Norway W.W.
Pulmonata	0.1	0.2	—
Opiliones	0.7	1.2	—
Arenacea	1.1	0.4	0.1
Acari	1.4	0.9	t
Insecta			
Collembola	1.2	0.5	0.3
Ephemeroptera	—	—	0.1
Dictyoptera	—	—	t
Plecoptera	0.1	0.1	0.1
Mallophaga	0.1	0.1	t
Hemiptera	32.5	12.5	1.0
Thysanoptera	1.2	0.1	—
Coleoptera	1.9	2.3	5.0
Hymenoptera	3.1	3.1	50.6
Lepidoptera	19.6	42.5	4.3
Trichoptera	0.1	0.4	2.6
Diptera	36.9	35.0	34.0

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SAMMENDRAG

Dietten til kyllinger av lirype *Lagopus lagopus* på Tranøy, Troms

I den første leveuken dominerte insekter i kyllingenes føde. De viktigste familier var Diptera og Lepidoptera. Det meste av plantematerialet besto av reproduktive deler. Forskjeller i kyllingenes diett i ulike geografiske områder, skyldes til dels ulik tilgang av potensielle fødeemner.

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